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ABSTRACT

This paper reports on a case study that was part of a 3-year longitudinal study about classroom discourse during a learning sequence related to environmental values and concepts. The lesson was planned and enacted by students in a fourth grade classroom during a field study. Whole class and small group classroom conversations and a field trip to a pond were recorded and interpreted in terms of knowledge production and use, goals pursued, and values. The data demonstrate how students are able to propose, evaluate, and justify sophisticated science-related questions and challenge book authority. Implications for science and environmental education are discussed. (WRM)

Knowledge production: a case study about values, epistemology and conflicts in a 4th grade classroom.

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Abstract

This paper reports a case study, part from a 3 years longitudinal study, about classroom discourse during a learning sequence related to environmental values an concepts, planned and enacted by primary school pupils from a 4th grade classroom while designing themselves and conducting a field study. The focus of the paper is the epistemology of the classroom, analyzed by means of the Helms & Carlone (1999) formulation about the commonplaces of science. The methodology involved recording classroom conversations in whole class and small group, videotaping an outdoor trip to a pond, keeping field notes and collecting pupils' productions. The results are interpreted in terms of knowledge production and use, and goals pursued, particularly goals related to values. The teacher strategies, particularly the ways to solve conflicts, are analyzed in connection with the classroom epistemology. The results show how pupils are able to propose, evaluate and justify sophisticated questions to be studied and behaviors towards environment, to challenge book authority and to evaluate the goals and, on the other hand, how the teacher strategies such as sharing the authority to evaluate, empowered students to attain these performances. Implications for science and environmental education are discussed.

Teacher: *"Look, now there is a person, M.* (researcher) *who is studying this classroom, isn't? Well: Could he do it if he took any of us out of the classroom?"*
Pupils: *"No, no"*
Teacher: *What does he want? He wants to study the whole class... with children, walls, tables, what is performed... The same happens with the pond... looking only to a newt, waiting for it to grow, to mate... it would be impossible to get an idea of the pond."*

1. Knowledge producing communities: rationale and objectives of the study

The transcription above shows the use by the teacher, during the planning of an outdoor visit, of an analogy between ecology studies and classroom studies that is precisely the reverse of the analogies frequently found in educational studies: the presence of the researcher in the classroom is used here to exemplify both the need for an approach to the pond as a whole and the need to do it in the field.

In the literature about environmental education there are plenty of studies showing deficiencies about environmental education practices in the school; many of them are just anecdotal activities such as planting a tree or recycling paper, disconnected from the curricular objectives. However, there are not so many studies about good practices, and our main objective in this study is to identify classrooms where environmental education is integrated in the current practice, to look for exemplar teachers whose strategies could be studied in order to provide suggestions for other teachers and schools. By integration of environmental education in the current school practice we understand including aims and goals related to the "for" the environment dimension either in the school project or in the objectives which teachers set for a term or subject, or in both instances. Of course, writing goals doesn't ensure its implementation in the teaching practice, and real integration would mean planning classroom tasks related to these goals, carrying them and evaluating its results. The Fingoi school, in the city of Lugo (Spain) was chosen to carry the study as it had, since 1958, aims such as:

> *"arousing interest in nature, knowledge, understanding and respect about it (...) as a resource or a mean for an integral, whole education"* and education with the goal of *"providing pupils with an instrument that will be useful in practical life. The purpose is not to give them a file of abstract knowledge, of erudition very far from the authentic, immediate problems from existence"*. (Memorandum on the Fingoi School goals, 1958)

The focus of this paper is the epistemology of the classroom, how knowledge is produced and used in it. The research questions have been framed using Helms and Carlone (1999) heuristic about the commonplaces of science:

– Is the dimension about the production of knowledge reflected, to some extent, in the classroom discourse? Are pupils playing an active role in producing and evaluating knowledge?

– How is the sociological dimension of science reflected in the classroom? In particular: which goals are pursued?

– Which teacher strategies are effective in fostering the organization of the classroom as a knowledge-production community?

Science education has to provide students with the opportunity of being part of a community involved in the production of knowledge, thus preparing them to participate in scientific practice understood, not only as activities carried on research laboratories, but as a variety of situations, locations and communities where science is created and used (McGinn & Roth 1999). These authors mention, as an instance of different locations, activist movements, which is a pertinent example in environmental education. The school what we choose as a subject of study has, as a prominent feature, that pupils are protagonists in the planning of learning tasks as well as of behavior rules, what made possible the exploration of features of a knowledge-production community. These features are difficult to document in conventional classrooms where the production of knowledge seems to be solely on the hands of the teacher.

Each teacher strategies reflect, in our opinion, her or his epistemology, her or his perspective about the nature of science and about how scientific knowledge is constructed. These perspectives may be explicit or implicit and the fact that the teacher is not aware of holding them doesn't means that she or he has any perspective. Helms and Carlone (1999) compare four different formulations («commonplaces») based on different views of the nature of science which may be used as research heuristics for framing the nature of science and science education. In this study we have used the authors' own formulation, reproduced below, to interpret classroom data, attempting to relate the teacher strategies to her epistemology:

> «Science is an activity in which people employ *lenses* and *methods* to investigate *questions* and produce *knowledge* concerning *natural phenomena,* all in a particular *context*, in the service of some *goals* or *set of goals.*» (Helms and Carlone 1999, authors' emphasis)

As Helms and Carlone mention this formulation combines different features of scientific activity. Following them we have grouped the features in three dimensions related to:

– The empirical nature of science: questions, lenses and methods

– The production of knowledge and the subject studied (natural phenomena)

– The sociological dimensions of science and its connection to society: goals and context.

Inside these three dimensions, several categories could be established in order to analyze classroom discourse and we propose a set of them, found in our study, in table 1.

Dimensions	categories
empirical nature of science	–questions to be studied –lenses –methods of study –knowledge sources & data types
production of knowledge	–knowledge production: protagonism –knowledge evaluation –authority in knowledge production –appeal to expert & expert status –use of analogy, metaphor –inscriptions
sociological dimensions	–power and status –Social negotiation –goals –Decision making –conflicts management

Table 1 Authors' dimensions to Helms & Carlone commonplaces of science

Not all of the categories in the table will be addressed in this paper, and in the results section, rather than discuss evidence for students talk or action which could be coded under each category, some relevant episodes are presented which, in our opinion, offer opportunities to explore the entanglement of issues such as knowledge evaluation, authority, status and conflict management in the classroom. Keeping in mind that our aim is to explore the process of knowledge production, the expectation is that the analysis of these episodes and issues would shed some light about who is producing the knowledge and how is this production carried on.

2. Methods, participants and data sources

This paper makes part of a 3 years longitudinal study, from 1993 to 1996. An intact group of Primary School pupils were followed during selected periods through grades 4, 5 and 6; that corresponding to ages 9 to 12 years. Here we will discuss data collected during the 4th grade. The participants are 25 pupils, 18 boys and 7 girls, aged between 9 and 10 years, and their teacher, who will be called here Ms. Ares.

Data collection involved audiotaping classroom conversations, corresponding to whole class discussion and to some small groups; some sessions, as the outdoor visit, were videotaped too. A researcher (second author) participated in the sessions as an external observer, taking field notes and he conducted interviews with the teacher. The pupils' productions were also collected and analyzed.

This paper is based on data collected during the 4th grade focusing on ecology and particularly on fieldwork. Ten days, in April-May 1994, were spent on the teaching sequence, with the following distribution: six devoted to the design of the field trip, three in the Nature Center and one of work revision. The outdoor visit, teaching strategies and classroom organization were designed by the teacher and, although discussed informally and in recorded interviews with one of the researchers (second author), were solely her design, without input from the researchers. Figure 1 represents an overview of the sequence of activities during the ten days.

(figure 1 about here)

The audiotapes were transcribed and compared to the observer's notes, so cues corresponding to non-verbal actions could be introduced. Then we sought to identify a sequence of steps or episodes in each session corresponding to periods of a certain coherence, for instance: pupils from group 6 propose pollution as an issue to be studied (session 3); pupils evaluate each other proposals (session 4); pupils and teacher assign tasks to be performed during the outdoor visit (session 5) etc. An analysis of the first sessions in terms of true dialogue (Lemke 1990) and of co-construction by pupils of their own behavior code is the subject of another paper (Jiménez & López 1999). Here the meaning of some episodes, in terms of the classroom epistemology, is analyzed using the Helms & Carlone (1999) frame mentioned above as well as other categories, such as construction of meaning, parables and narratives, rephrasing etc used by Ogborn et al (1996) to interpret teachers actions and explanations.

3. Results: knowledge production in the 4th grade

The data discussed here were collected in 10 days in April-May 1994, corresponding to the planning, realization and evaluation of an outdoor visit to a pond. Although the first dimension, how is the empirical nature of science reflected in the classroom, is not discussed in the paper it is worth noticing, as it provides some information about the context, how the pupils were involved in the decisions about what to study. For instance, data from sessions 3 and 4 which were devoted to discuss the question "What do we want to study?", show that pupils proposed a list of questions to be studied which are relevant when compared to the reference field of ecology. Some instances are pollution, the food chain, the life of frogs and tadpoles, "cannibalism" among animals etc.

About knowledge production, a variety of issues related to the production and evaluation of knowledge can be documented in the transcriptions. One of these relates to the category that we have termed authority in knowledge production, and that we see different from knowledge production protagonism. Whereas the second refers to who is actually proposing issues to be studied, defining or applying concepts, etc., the authority issue refers to the person or instance that is *perceived* as having the authority to doing so. An instance is seen in the following exchange:

Session 3

182 Néstor: The food chain... it is... we have...
183 Fina: What we want to know is what do they eat, the animals in the pond.
184 Néstor: No, not all of them...
(...)

186 Fina: We want to know what do they eat and how do they eat one another and which one eats that other...
187 Teacher: And: How are you going to study that?
188 Lino: First we will look into a book, then we will observe it.
189 Tina: And see if it is true...
190 Lino: We will observe whether it is true or perhaps they are wrong... perhaps the book is telling this only about one pond and not all the ponds in the world... then we will have to look there and see what happens...

This is interpreted as a challenge of book authority contrasted with the own pupils acting as producers of knowledge. Lino (line 190) suggests that the information from the book can be wrong or, at least, that it could be useful only for certain contexts, in other words, that it has a limited domain of reliability. The question of the limits in domains of knowledge, the extent to which some knowledge (models, here for instance the foodweb)

is of universal applicability while other is not, is quite sophisticated, and what could be seen here is just an instance of acknowledging the existence of, at least, two sources of data: the book and the own pupils.

On the other hand this exchange could be interpreted also as an appraisal of the status of empirical data, evidence about the food chain found by students in the actual pond, versus written sources. The connection between these two issues, authority to produce knowledge and knowledge sources in the transcription is represented in figure 2.

(figure 2 about here)

This is but an instance about how students are acting as knowledge producers, and many other could be found along the transcriptions showing the active role of the pupils in proposing issues to be studied and ways of studying it, in Lemke's (1990) terms talking science. A detailed account of the proposals related to attitudes and values in the construction of their own field code is the subject of another paper (Jiménez & López 1999). The field code produced by the pupils is reproduced in appendix 1.

4. Power and status: Who can evaluate?

One interesting category in the sociological dimension of science reflected in the classroom is the issue of power and status in the community. Evidence about status could be found for instance in the participation of teacher and students in the classroom dialogue and, particularly in how the teacher shares the authority to evaluate.

participating in the dialogue at the same level that the pupils

This participation doesn't mean that Ms. Ares is not guiding the processes of elaboration of the code, proposal of the issues to study and decisions about how to study the pond, but that her leadership is achieved through subtle methods, more through the ability to synthesize proposals and to find solutions to conflicts, that by an appeal to authority. The evidences for this participation as equal are found more in the tones and countenance that in particular lines, but a good example is the discussion about the proposals in session 2 where the teacher many times is just repeating or rewording the pupils' proposals or asking them their opinion, as for instance in the excerpt below when the students from group 1 are proposing what later would be rule 3

Session 2

182 Rosa: Once you are close to the pond, do not begin to pick plants and animals. Be quiet, wait a little, and so perhaps you could observe the animals and check how they behave in their natural environment.
183 Teacher: Look, I was asking Clara and it turns out that Clara had it already written... Had you written it? Had the group written it before?
184 Julia: No, before it was not like that, but we pick it... pick it from the sheets that you gave us to read, because we like it
185 Teacher: [addressing the whole class] *What do you think?*
186 Students: Yes, yes...
187 Teacher: All of you like it as it is?
188 Students: [louder] *Yes, yes...*
189 Teacher: I like it too... so let's add it to the code.

Other instances of this participation in equal terms could be seen in the fragment of transcription about conflict solution reproduced below.

sharing the authority to evaluate

It could be seen as a particular case of shared participation discussed above, but we think that it has a particular significance, since in conventional classrooms is only the teacher who exercises this authority. This shared assessment is documented in many occasions, for instance in session 1:

session 1

129 Saul: Once I caught a toad in the country and I put him in a box but he jumped high and went out, then I put him in a big bottle so he couldn't get away... And I threw him flies and small worms and he should eat them because they disappeared... and later, as he was so big, he jumped but couldn't get out; but then one day when I went back to the country he was dead
130 Teacher: And: what do you wanted the toad for? Why did you wanted to have it in a bottle?
131 Saul: ... So... for nothing in particular [some pupils laugh] *I don't know... to see it...*
132 Teacher: And, Do you think that to see it is a reason enough to pick an animal from its environment?
133 Saul: No... but I wanted to see what he eats (...)
134 Teacher: Yes, Rosa?
135 Rosa: I think that before picking a toad or a frog or tadpoles from a pond, first you must know why do you want them... what do you want to know... and also where are you going to keep it... and what are you going to feed it
136 Teacher: Yes, Cosme?

When Saul (129) tells about the toad that he caught and keep until it died the teacher doesn't criticize him, just raises the question about what do you want the toad for and, after his answer, ask the students to reflect about his justifications. Then Rosa advances a

first proposal of planning before picking and keeping animals (135) and again the teacher doesn't evaluate it –although, from the next sessions, it will be apparent that she disagrees with the idea of keeping animals in captivity– but suspends the judgement until the issue is discussed in the class and a decision adopted by the majority of pupils as their own.

The teacher attitude of sharing the evaluation with the pupils could be appreciated also through the discussion of proposals in session 2, soliciting pupils' opinions for each proposal (e.g. as seen in lines 182 and onwards reproduced above) and treating these opinions in a serious way. The proposals are not written down until agreed by all the community, as documented through session 2.

There is also an episode which shows the active role of the students, the evaluation of their own performance during session 10, in particular the importance of having a behavior code for the outdoor visit, elaborated by the pupils themselves.

In summary, about the status of the participants, it could be said that it is documented in a number of verbal and non verbal exchanges how the teacher shares her status with the pupils, not only placing responsibility to plan and to decide on their hands, but also sharing the authority to evaluate.

Another category inside the sociological dimension is the question of goals driving the sessions studied here. During all the planning and in the visit itself, the goal which seemed to be placed higher in the hierarchy was the one related to development of attitudes and values of respect towards the environment, which even took the biggest portion of the planning sessions and the first ones, as seen in figure 1, while the other two goals, related to questions to be studied and methods to study them were in a certain sense subordinated to it.

5 Teacher strategies: promoting participation and solving conflicts

All along the sessions the pupils showed a considerable degree of autonomy, advancing proposals, discussing them and acting consequently during the field study. But this doesn't means that the teacher, Ms. Ares, was solely an observer, or that the pupils performed all this activities unguided. On the contrary, all the sessions were carefully designed, from the sequence (see figure 1) which began with the attitudes (in her own words: how should we behave?), followed by issues to be studied (what to do in the pond?) and by the planning of tasks and procedures (how to do it?). Ms. Ares claimed that she planned each session or group of sessions using as starting point the pupils' interests and previous knowledge and that the programmed activities were designed so they had to interact with the texts and materials that she provided.

From the transcriptions and the observer notes, we identified a number of strategies that seem connected with the pupils' performances, and several of them we see as related to what Lemke (1990) calls true dialogue. The ones related to the sociological dimension, participating as a pair in the dialogue and sharing the authority to evaluate, have been analyzed above. First will be discussed briefly three connected strategies: exploring pupils' ideas and attitudes, praising pupils' proposals and reformulating and synthesizing pupils' proposals as this could help to clarify the teacher strategies taken as a whole. Then their strategies for conflict resolution will be analyzed and illustrated with excerpts from the transcriptions.

Exploring pupils' ideas and attitudes through not directive questions

It is well known among researchers that, if you really want to know your informant's ideas or opinions, the questions have to be non-directive and try to avoid bias. The majority of the questions of Ms. Ares could illustrate directions about interviews or about how to collect information in classrooms, like the ones proposed by Osborne and Freyberg (1985). In other words she doesn't provide cues for the answer or implies that some answers could be better than others.

Some instances:

«*What did you do* [in a pond]?»	sess 1, l. 20, 26
«*What happened* [to the tadpoles]?, *how was it?*»	sess 1, l. 39, 61
«*Is there someone else that wants to tell us something?*»	sess 1, l. 69, 73, 91
«*Why* [didn't see anything]?»	sess 1, l. 107
«*Why so* [about proposals 2, 3...]?»	sess 2, l. 101, 130...
«*What do you think that is the most important thing...?*»	sess 1, l. 115
«*Are there other reasons?*»	sess 1, l. 150
«*Do you like it?*» «*Is it O.K.?*» [about proposals]	sess 2, l 86, 109...
«*What do you think about it?*» [about proposals]	sess 2, l 120, 204...

We believe that, besides being not directive, these questions promote true dialogue. One reason is that most of them cannot be answered by a simple «yes» or «no», they require an elaboration, for instance «what happened...?» or all the «why?»; also they promote the participation of pupils. Participation in fact was high, and for instance, in the first session when 24 pupils were there, 20 of them participated. In the second session, 23 out of 25 contributed, while the other two pupils (differents from the ones who didn't talked in session 1) only said yes or no when asked their opinion.

showing interest and praising pupils' proposals and work

Like the strategy discussed before, this is related both to promote pupils' participation and to the exploration of their attitudes, previous experience and knowledge. Some instances of it:

«*Ah! This seems very important*»	sess 1, l. 117
«*It looks important to me*»	sess 2, l. 154, 179
«*Very good, very good... it is a good point*»	sess 2, l. 163
«*It looks fine*»	sess 2, l. 233, 273
«*It is a wonderful idea, very good... How did you get it?*»	sess 2, l. 270
«*I think that we all wrote very important rules...*»	sess 3, l. 22

These words of praise contribute to the creation of a classroom climate of trust and confidence. They help to make the pupils feel safe to propose any idea because they know that nobody is going to scold them or even tell them that they are «wrong»; also the pupils could feel that they have a role in the activities going on in the classroom, that they are protagonists and not just spectators.

reformulating and synthesizing pupils' proposals

Another aspect of Ms. Ares' strategies related to the discussion of proposals is that, rather than evaluating them, she attempts at reformulations which could clarify its meaning or, in other occasions at synthesizing different ideas proposed by pupils, as documented along the discussion of the different group proposals during session 2.

finding compromise in conflicts

A number of conflicts and disagreements arouse during the discussion. Perhaps the most interesting of them was a hot debate about catching or not catching animals; other of different nature were the discussion about a proposal which included a mention to binoculars and a debate centered about the novelty (or not novelty) of one of the pupils' proposal.

In the debate about picking animals, the teacher strategy involved, first allowing students to express freely their opinions, not evaluating herself the proposals and even not criticizing openly the one which said that animals were to be caught; then delaying the issue for the next day, allowing, she said, time for the two students who represented the minority position (to pick and keep animals) to get more information about it. Next day she focused the issue, not on pupils' wishes, but on the *difference* it made for the animals

to live free or captive, what made difficult for the pupils to find reasons to justify captivity. Part of the debate about this issue in session 2 is reproduced below:

Session 2: whole class discussion

line	Actor	Transcription	*interpretation*
119	Rosa	So... that when we arrive there, we should wait and should not pick plants and animals just as we arrive. (...)	*proposal wait before picking*
131	Rosa	Because we shouldn't... and besides if we don't know them, they can sting us...	*justification for not picking*
132	Néstor	Why?...	
133	Rosa	Because they can sting or bite us...	
144	Hugo	Thus, wait until they are unawares, they feel safe... until they are not on their guard, to be able to catch them.	*interprets: to better catch*
145	Teacher	Look! let's see... remember that the question is not... not to make rules to be a good hunter (...) perhaps we are not going to catch any frog the day we go to the pond.	*teacher raises doubt about catch*
146	Eloy	Are we not?	
147	Zoilo	Are we not going to catch them *(animals)*?	
148	Teacher	I don't know... we all will have to decide about it, depending on what we want to study (...)	*places decision in community*
164	Hugo	Besides, if we go around picking plants and animals, the food chain may break in this place and other may lack food... (...)	*justification for not picking*
199	Néstor	We should not catch animals and, if you catch one to observe it, then put it back in its own environment, where it was.	*proposal: not catch*
201	Eloy	Well, I believe that we could pick some animals and keep them, like frogs.	*disagrees with 199*
202	Fina	Why? Why frogs?	
203	Eloy	Because there are many frogs and even if we pick one to keep it, and study it, it wouldn't matter...	*justification*
204	Teacher	What do you think about it?	*asks opinion*
206	Lino	Besides, it does matter. Frogs and all the animals are always better in their natural environment, otherwise they could die (...)	*justification:*
224	Teacher	(...) Then, as Eloy and Mario disagree, they will get some more information about this, the differences for the animals among living in their environment or in captivity and tomorrow they will tell us again their views.. Do you agree?	*delays decision in search of agreement*

It can be seen that, although the teacher is looking for a collective evaluation and decision, she expresses clearly her opinion in line 145, not directly about the issue of catching, but about the nature of the rules "not (...) to be a good hunter", which has clear implications;

a few turns later, in 148 she says again that "we all will have to decide about it", placing the decision in the hands of the class. The discussion gets hotter when debating group 6 (Néstor) proposal, and, after the arguments supporting picking frogs from Eloy and another student, or against picking them from the rest of the class, begin to be repetition of the same ideas, the teacher delays the issue for the next day. This would allow, on the one hand, to cool the disagreement, and on the other hand, to dismantle Eloy and Mario (not quoted here) position, as they will consult more texts on which they would have difficulties to find reasons for keeping animals in captivity. It has to be noted that the strategy of the teacher (see line 224) is to focus the issue, not on pupils' wishes, but on the difference it makes for the animals to live free or captive and certainly this move makes difficult for the student to find reasons to justify captivity. Nevertheless, she places the responsibility in their hands, waiting for them to decide, although the majority of the class has already an opinion against catching. Is this search for consensus what we think particularly interesting in this occasion. Figure 3 summarizes the teacher strategies connected to the transformation path of this proposal, until finally worded as rule 4 (see appendix 1).

(Figure 3 about here)

Also in session 2, two more conflicts arouse although its nature was not an issue so deeply related to attitudes and values. One of them was centered on including binoculars in one of the rules:

Session 2

240 Katia: If we take binoculars, perhaps we could better observe many things, mainly birds.
241 Cosme: (...) it is a good idea... for instance, I have binoculars and so we could observe the animals without running into them... without making a fuss...
242 Ignacio: But if we observe them carefully, there is no need of binoculars.
243 Paula: Yes, but the farther we could stay, the better, in order to observe what they do... how they behave... otherwise they would be easily scared (...)
244 Ignacio: But if we are careful, perhaps we won't need them... besides, we won't have binoculars for everybody. Won't we?
245 Teacher: Well, I think that all of you are right. It is good to be able to observe from a distance, in order to see how the animals behave, but it is also true that we won't have binoculars for everybody. And of course the most important it is always to be very careful and respectful with the environment... Let's see... we could set a rule taking all this into account... for instance, if we say: if you have binoculars, use them before getting close, so you could observe the animals without scaring them; and if you don't have binoculars... you could observe first from a distance and then getting closer little by little, carefully... What do you think about it?

It seems that, while the discussion looks as somewhat technical, the teacher let the pupils talk for and against, but after Ignacio suggest that there would be not enough binoculars, she attempts at a compromise, first praising the arguments on both sides, and then trying to synthesize them in a sentence that after will be summarized in rule 2 (see appendix 1).

The other conflict relates to the category of social negotiation, into the sociological dimension, to the novelty of a proposal which, another group claimed, had been suggested before:

Session 2

252 Waldo (group 4): Take care of not putting together carnivorous animals with the other.
255 Teacher: What does it mean? Why do you want this rule?
256 Waldo: It means that when you are studying animals, if you are keeping them for a while, do not mix carnivorous with the other, because they could eat them...
258 Cosme: But we said that already, when it was... that you should always know when to keep and how to keep the animals that you take...
259 Xosé (group 4): But now it is... it is more direct, because it refers only to observation... not to mix them to observe them.
260 Urbano: Well, but I also believe that there is no need for more, because we wrote it before, when we said that you have to prepare everything in advance before catching the animals to observe them... Only if you want to write here something else, otherwise is repeating it (...) but I believe that there is no need...
261 Teacher: What do you think?
262 Pupils: [murmur]
267 Teacher: Then we could write: having everything planned before picking animals to observe them,... being careful not to put the carnivorous ones together with the other. Is it o.k.?
268 Pupils: Yes... yes...

The conflict here is among group 4, proposing what they see as a new rule, and the other pupils, who think this a particular case of planning. One important issue about classroom interaction is that everyone should perceive himself or herself as contributing to the task, and denying the originality of group 4 proposal should be felt by them as a big disappointment. The suggestion of the teacher is to add the issue of meat eaters to the previous rule, trying to compromise with both sides. The final wording, as rule 6, can be seen in appendix 1.

In summary it can be seen that the teacher attempts to find compromises in the conflicts arousing in the discussion, being careful about pupils's feelings, so any of them could feel that he or she is a "loser". This task was more difficult in the conflict about catching animals, when she had to reconcile the consensus in the group with the values of respect to environment and living beings.

6. Goals and values: discusion and educational implications

The analysis of data from recorded dialogues and other sources using a heuristic based on Helms and Carlone (1999) made possible to document several features of knowledge construction in a 4th grade class. Pupils were given the opportunity to act as a knowledge-producing community and they planned and evaluated the issues to study, the methods and elaborated a behaviour code. They considered themselves knowledge producers, challenging, for instance, book authority.

One interesting feature about classroom epistemology is the question of goals driving the sessions studied here. The goals pursued in connection with the visit to the pond have to be viewed in the context of the broader goals of the school, which, as quoted before, include «interest in nature, knowledge, understanding and respect about it» and «providing pupils with an instrument that will be useful in practical life». Analysed in this perspective, the planning of the pond study and the visit itself has goals more comprehensive that the conceptual knowledge about frogs, insects, the food chain or other aspects of pond life; the teacher invested a great deal of effort in work related to her first question –how should we behave?–. In fact this question, and the construction of the behaviour code which followed it, occupied two whole sessions and part from the third, almost three full hours, whereas each of the others two questions used two sessions, or a little less, about two hours and 25 minutes each (see figure 1). This distribution of time is not trivial, taking into account that the portion of time allocated to attitudes and values in conventional science classrooms is minimal or not existent at all.

The practice of science is influenced by the context, but also influences the context, the environment in which takes place. In this case, the study of the pond may modify the pond and its surroundings unless certain precautions are taken. The teacher intends to promote an awareness of the extent of this influence and the importance of being careful. This can be documented for instance in line 132 from session 1, reproduced in section 4, when she asks whether «to see it» is enough reason to pick an animal from its environment, and also in lines 145-148 from session 2, reproduced in section 5, when she questions the idea of catching frogs, saying that perhaps they will not do it «depending on what we want to study». This raises the issue of the different questions that could be explored in an outdoor visit: some may require picking animals, but other don't need it; certainly the questions selected pertain to this second category as seen in the transcriptions from sessions 3 to 6. In other words: there is a hierarchy of goals and the respect for the environment is placed at the top; only the studies which do not entail disturbing the pond will be carried. This could be illustrated also with the behaviour code produced by the students (see appendix 1), for instance rule 3 says that being quiet

«perhaps you could observe the animals and see how they behave in their natural environment». It could be said that during all the planning –and in the visit itself, not analyzed here– the goal which seemed to be placed higher in the hierarchy was the one related to development of attitudes and values of respect towards the environment, which took the biggest portion of the planning sessions, while the other two goals, related to questions to be studied and methods to study them, were in a certain sense subordinated to it.

The teacher strategies show a student-centered orientation, she purposely placed the responsibility for designing the learning tasks and behaviour code in the hands of the pupils, and drived the process through a pattern of clearly designed tasks and supporting materials. During the sessions the teacher created a climate which allowed pupils to talk freely and she prompted the participation of those who tended to be silent. She guided the discussions towards the construction of a behaviour code centered around the respect for the environment avoiding to impose her opinions, promoted a classroom climate where dialogue was possible, praised the pupils' initiatives and proposals and took steps to solve conflicts without imposing her views. We think that the strategies of the teacher and allowing enough time for controversial issues are crucial in the development of values and attitudes. Her methodologie reveals an epistemological view presided by goals about values (related to respect for the environment). This could be illustrated by the conflict on catching animals, where the values hierarchy, placing at the top the well being of the animals, rather than the wishes of the pupils, is apparent. In our opinion this conflict is a good example about the difference existing among paying attention to pupils' interests and motivations and blindly following all their desires: the pupils, even in their 4^{th} grade, should understand that there is a need for rules. The study focused on issues which could be documented along the path from claim to behaviour or action. We were interested not only in the formal construction of the code, but also in its enactment, as there is a difference, and sometimes an inconsistency, among declaring a commitment to an attitude or value and acting consistently with it (Lucas 1982, Tilbury 1995). The pupils were observed during the outdoor visit and, with few exceptions, their behaviour was consistent with the code. We want to suggest that perhaps this consistency among claimed values and behaviour is more likely to be found when the values have been agreed upon by the community and not imposed from an outside authority, be this teacher, school, or parents.

It couldn't be denied that these strategies would not be easily transferred to other schools and groups. The greatest difficulty is that these methodologies take time; of course in a conventional classroom a teacher would have spent barely a couple of days –and not six–

preparing an outdoor visit. On the other hand, Fingoi is not a standard school and the fact that the pupils were used to debate and to elaborate and keep their own rules for classroom behaviour (López & Jiménez 1995) has to be taken into account. We do not imply that this is the only way to perform environmental education, but what we suggest is that it is a good way to perform it, that these efforts and time are worthwhile. One purpose of this paper is to offer teachers an exemplar of good practice in environmental education as complementary of many studies that, during the last decade, have shown the deficiencies of practices that are labelled environmental education without really tackling at a deep level with the values *for* the environment. We believe that just telling teachers «don't do that!» may result in discouraging people about trying to integrate environmental education in their practice; on the contrary, showing them what a teacher and her pupils accomplish and how they do it may help others to follow along this path.

There are further studies which could help us to better understand the processes of integrating environmental education, for instance the reasoning and argumentation dimension as the justifications offered for the rules; the analysis of the pupils' revision, the designing of the tasks related to conceptual contents. Other studies with different age levels could shed light about the development of attitudes in adolescents.

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Appendix 1. The behaviour code on the field. 4th Grade pupils, Fingoi school

Rules to be a good observer

1 We must go slowly and silently, in order to respect the environment.
2 If you have binoculars, do use them before getting closer; if you don't have them, observe from a distance, then get closer little by little, carefully.
3 Once you are close to the pond, do not begin to pick plants and animals. Be quiet and so perhaps you could observe the animals and see how they behave in their natural environment.
4 We must not catch animals and if we take one to observe it, then we should put it back where it was.
5 If you are going to pick an animal, be careful with the ones you don't know.
6 We must have a plan before picking an animal. The carnivorous ones must not be put together with other animals.
7 Even if we were catching very small numbers of animals, this would alter the nature.
8 We must be very careful with all the surroundings of the pond, as everything makes part of the same environment.

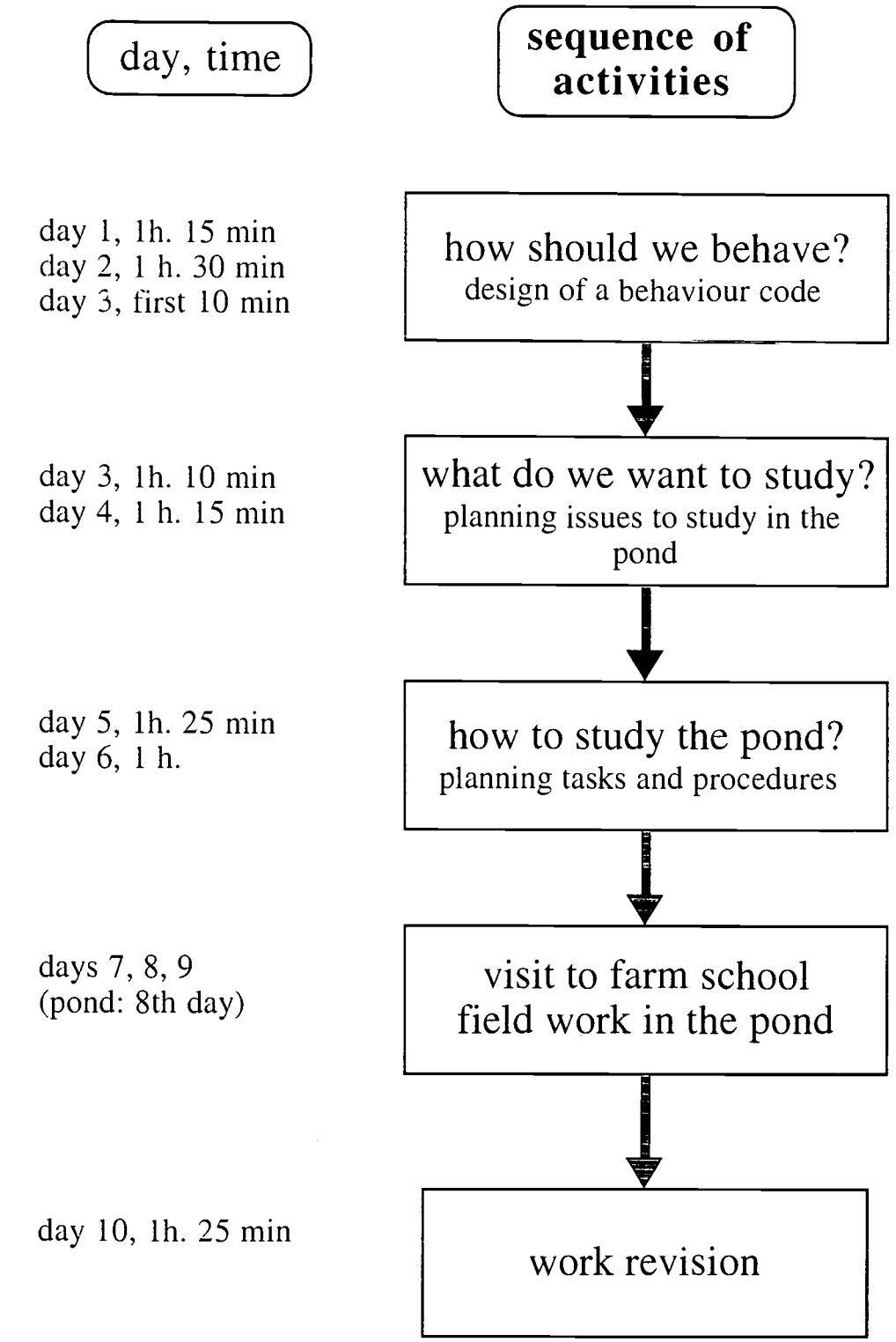

figure 1

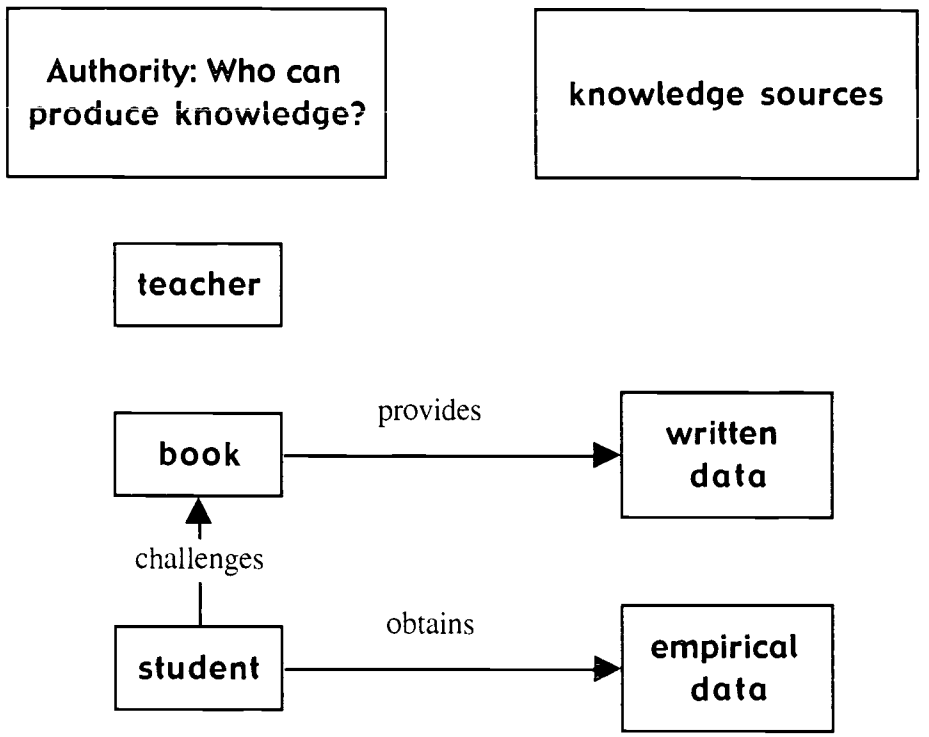

figure 2

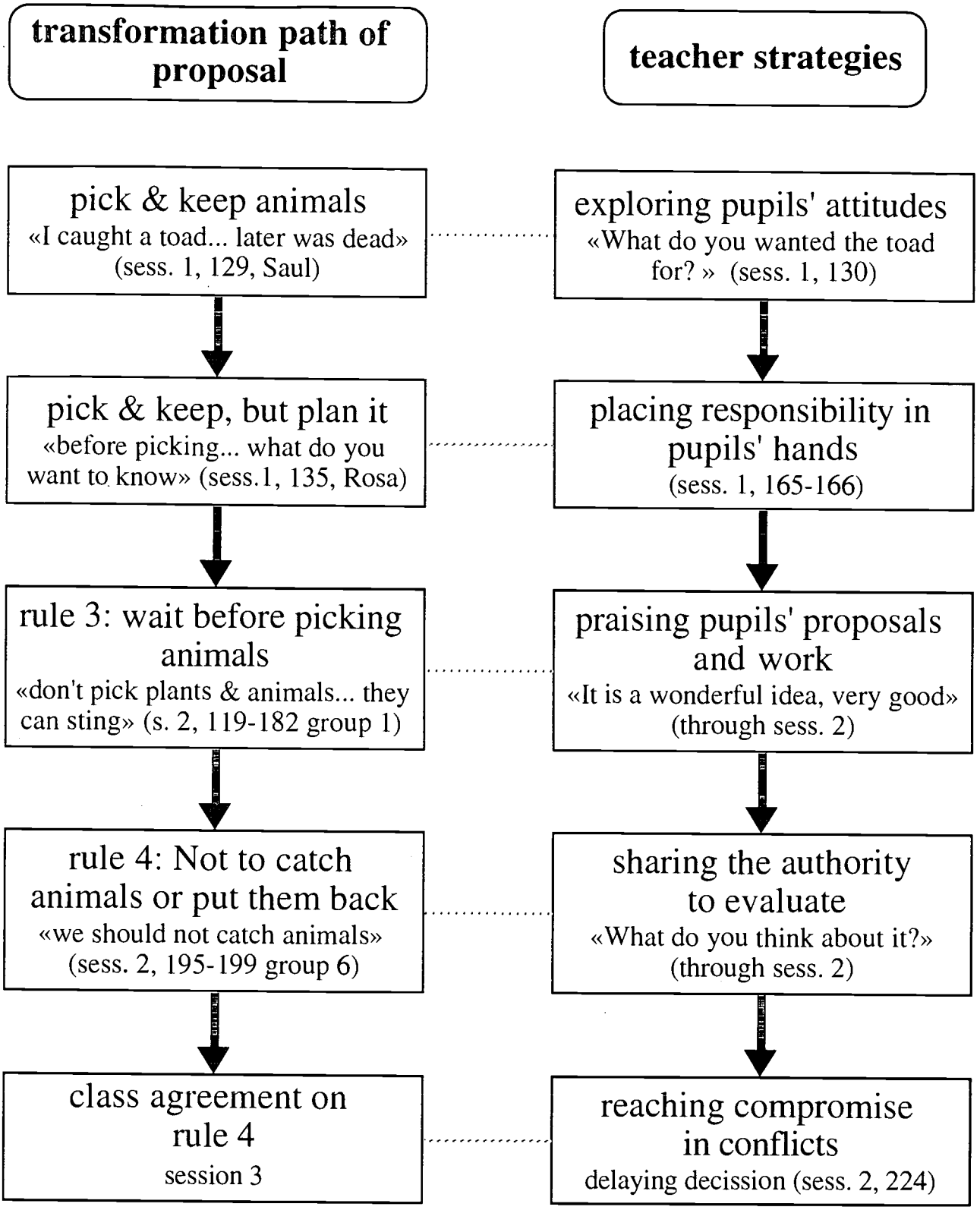

figure 3

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